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THE EFFECTS ON LEARNING OF STRUCTURAL DRILLS IN SPANISH BROADCAST VIA HIGH FREQUENCY AM RADIO.

BY- COOK, H. ROBERT
INDIANA UNIV. FOUNDATION, BLOOMINGTON

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RADIO BROADCASTS AND PERSONAL RECEIVERS FOR EACH STUDENT WERE USED IN A SPECIALLY ADAPTED SPANISH LANGUAGE PROGRAM. THE BROADCASTS CONSISTED OF SPANISH DRILLS AND A LIMITED AMOUNT OF TEXT MATERIAL PROGRAMED IN A STIMULUS-RESPONSE PATTERN. EACH SET OF DRILLS LASTED AN AVERAGE OF 15 MINUTES AND WAS REPEATED CONTINUOUSLY THROUGHOUT A 15-HOUR BROADCAST DAY. PRETESTS WERE ADMINISTERED AND INCLUDED THE CARROLL-SAPON MODERN LANGUAGE APTITUDE TEST, THE AMERICAN COUNCIL ON EDUCATION COOPERATIVE SPANISH TEST, THE PIKE PHONETIC PLACEMENT TEST, AND A LOCALLY DEVISED COMPREHENSIVE TEST. TWO GROUPS NUMBERING 16 AND 11 STUDENTS WITH COMPLETE RECORDS WERE STUDIED. THERE WAS NO TRUE CONTROL GROUP SINCE IT RECEIVED SOME OF THE EXPERIMENTAL TREATMENT. THE GROUP DESIGNATED EXPERIMENTAL WAS GIVEN CONSIDERABLY MORE DRILL AND DID DEMONSTRABLY BETTER ON TESTS. THE CONCLUSIONS WERE EQUIVOCAL, AND THE AUTHOR RECOMMENDED THAT ANY FUTURE STUDY MUST CONSIDER THE SEPARATION OF EXPERIMENTAL AND CONTROL CLASSES TO PREVENT CONTAMINATION OF THE DATA. (JK)

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The Effects on Learning of Structural Drills in Spanish Broadcast Via High Frequency AM Radio

Author

H. Robert Cook

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1. Purpose. One of the difficulties encountered in the setting up of any language program which is designed to teach the oral skills is that of providing adequate exposure to the spoken language. Intensive, repeated, and prolonged participation in habit-producing exercises in the language is needed. An ideal situation would call for unlimited availability of some medium which could provide the necessary language drill activities. It has been demonstrated by some experimental intensive programs, such as Albert Valdman's Multiple Credit Intensive Audio-lingual French, that a conventional language laboratory can provide sufficient student contact hours for highly successful instruction. But by contrast, more traditional courses require students to spend an average of only two to four hours in the language laboratory each week in addition to their regular class hours. And unless high quality materials are used, difficulty is often encountered in maintaining interest or even regular attendance.

It is hypothesized in this experiment: 1) that other things being equal, students who are equipped with small transistor radios enabling them to receive language drills at almost any time or any place will be exposed to more hours of contact with the language materials than they would without this advantage, and 2) that this greater exposure will enable these students to obtain a higher proficiency in the spoken language.

2. Personnel. Assisting in the experiment were Robert K. Fritz who helped in the actual teaching of both sections, Dr. Peter E. Dress, specialist in statistical analysis at Purdue University, and Professor Nick A. Fattu who acted as research consultant several times during the experiment. Other persons involved were a number of native speakers who recorded the drills, and two part-time secretaries. Many valuable ideas,

suggestions, and helpful criticisms were obtained from Professor Albert Valdman personally and from observation of his program. The active cooperation of Norman L. Mikesell, Director of the Language Laboratory, and Elmer Sulzer, Director of the Radio and Television Department at Indiana University, made this experiment possible.

3. Technical Apparatus.

3.1 FCC Authorization. More than a year in advance of the experiment, investigation was begun to determine at what frequency, with what type of equipment, and under what service this research could be conducted. Among the systems investigated were carrier-current transmitters authorized under part 15 of the F.C.C. Rules and Regulations, a one hundred milliwatt citizen's band transmitter authorized under part 19, an experimental station for "Communications Essential to a Research Project" authorized under part 5 and a ten-watt educational F.M. station authorized under Part 3. Exorbitant expense and inadequate broadcast coverage for installations at Indiana University eliminated the first two possibilities. A ten-watt educational F.M. station would have been desirable, but it would have been difficult to prevent anyone in the control group who owned an F.M. receiver from taking advantage of the broadcasts. It was decided that an application for a license in the Experimental Radio Service would be filed. After considerable investigation of the frequency spectrum in and around Bloomington, the frequency of 27.245 Mc/sec was selected, and negotiations to obtain a narrow-band F.M. transmitter and receivers at this frequency were begun. It was later discovered that the delivery date on the receivers would have to be postponed beyond the beginning date of the experiment. The only recourse was to change the whole system to A.M. An appropriate transmitter was obtained, and the license was modified accordingly. Initial broadcast experimentation indicated that some interference to the Citizen's

Radio Service would result at 27.245 Mc/sec. The license was modified, changing the frequency to 27.275 Mc/sec, and the crystals were ordered at this frequency.

3.2 Equipment.

3.21 Radio Equipment. A Collins 32V3 transmitter modified for crystal control at 27.275 Mc/sec. and U.S. Communications Corporation Pagefone receivers, crystal-controlled at the same frequency, were used.

3.22 Tape Playback Equipment. Four T-1600 automatic-rewind tape recorders were donated for the project by Revere-Wollensak, a subsidiary of the 3M Company. Arrangements for the grant of the electronically controlled tape record-playback machines were effected by Mr. J. C. Landen, Marketing Director for Revere-Wollensak, and Norman L. Mikesell, Director of the Language Laboratory and Audio Learning Center, Indiana University.

Playback equipment in the language laboratory was connected to the transmitter in the Radio and Television building by means of telephone line and matching networks. This made playback possible from either location.

4. Procedure

4.1 General Method and Research Strategy.

4.11 Sample Plan and Procedure. During the 1963 spring semester at Indiana University, Spanish sections S101-1 and S101-2 were selected to be the two groups which would participate in this experiment. The first will be referred to as the experimental group or group 1 and the second as the control group or group 2. These were regular elementary Spanish sections involving mostly freshmen with some sophomores and upperclassmen. Random selection was assumed since no factors concerning the experiment were allowed to influence the enrollment of either section. The beginning enrollments of groups 1 and

? were 23 and 27 respectively. By the time of the first hour exam these figures had dropped to 19 and 24; after the first hour exam they dropped to 16 and 12, and only 11 of the 12 who remained in group 2 had complete records at the end of the semester.

During the first phase of the experiment, group 1 served as the experimental group (with radios) and group 2 as the control group (without radios), and comparisons were made between groups. During the second phase, radios were given to group 2 and comparisons were made within group 2 as well as from group to group.

4.12 Treatments and Program Structure. The effects produced by the addition of radio broadcasts and personal receivers for each student to an especially adapted Spanish program constitute the variation which this experiment attempts to measure. The broadcasts consisted of Spanish drills and a limited amount of text material programmed in a stimulus-response pattern in such a way as to free the student from the necessity of following written material while participating. Each set of drills lasted on the average about fifteen minutes and was repeated continuously throughout the fifteen-hour broadcast day. The broadcasts were from 9:00 a.m. to 12:00 midnight daily except Sundays, when they were from 1:00 p.m. to 12:00 midnight. The small receivers could be easily carried by those students who wished to make use of them during off moments throughout the day.

Essentially, this experiment seeks to discover whether more skill in speaking and understanding can be obtained in the Indiana University elementary Spanish program without sacrificing reading and writing proficiency by presenting the material in drill form using radio broadcasts. While simultaneous presentation of all four skills is not considered desirable, it was necessary to make sure that none of the Spanish 101 students would be handicapped when they enrolled in Spanish 102.

So the material used for the regular S101 sections was completely reworked and presented in structural drills. The order of presentation was kept approximately the same and the vocabulary and grammar content was kept exactly the same. In this way the two sections taking part in the experiment were prepared to take the same examinations that were given to the other Spanish 101 sections. Most of the quizzes and all of the exams devised for the sections taking part in the experiment were of the listening comprehension or stimulus-response variety.

Three hundred and three structural drills were prepared, mimeographed, and recorded. The students were required to master these drills orally, but were also asked to fill in the correct responses on the mimeographed sheets as part of their written assignments. Pronunciation drills were used at the beginning, but they were discarded when it was discovered that the control group was having considerable difficulty in mastering the grammatical structure. For most of the experiment four-phase drills were used. That is, after an initial stimulus, a pause was left for the student's response, a confirmation or correct response was given, and another pause was left for the student to repeat, correcting his pronunciation.

4.13 Controls. During phase I of the experiment group 2 served as control group, but it seemed obvious by mid-semester that this group would not be able to keep up the pace which had been established. More than 55% of the group 2 students had either dropped or transferred, and there were too few students remaining to provide a reasonably large control sample. Moreover, there was some concern as to the possible fate of those remaining in this group if the downward trend was allowed to continue. Thus it was felt that continued comparison of group 1 and group 2 as experimental versus control would not yield as much information as the comparisons

which could be obtained by equipping group 2 with radios.

During the controlled part of the experiment there was a special problem in isolating the two groups. This arose because their chief difference consisted in the fact that the experimental group received exposure to oral drills by radio as well as in class and the language laboratory while the control group's exposure was limited to the latter two media. Thus to keep the two groups separate, it was necessary to prevent the control group from listening to the broadcasts. This did not turn out to be as great a problem as was originally expected since receivers at 27.275 Mc/sec. are not readily available. Equipment was, of course, issued on the basis of a signed statement (see form I, Appendix).

4.2 Data Gathered and Methods Used.

4.21 Tests and Test Descriptions.

4.21.1 Pretests. The Carrol-Sapon Modern Language Aptitude Test, the American Council of Education Cooperative Spanish Test, the Pike Phonetic Placement Test, and a locally devised listening comprehension test were administered to both groups at the beginning of the semester.

4.21.2 Midtests and Posttests. Tests of four varieties were administered as midtests and posttests: 1) Multiple choice listening comprehension tests based on the structural drills (tests B and D), 2) Stimulus-response type tests measuring ability to make appropriate written responses after hearing a pattern example and corresponding cue (tests E and G), 3) Stimulus-response tests measuring ability to make appropriate oral responses after hearing a pattern example and corresponding cue (tests I and J). 4) Written tests administered by the Spanish department which measured ability in grammar, translation, vocabulary, reading, and writing (tests A, C, F, H and K).

Tests J and K covered the entire semester's work. Since they did not distinguish between phases I and II, they were not analysed with the other tests.

4.22 Outline of tests and testing plan.

Pretests: (see 4.21.1)

1. MLAT
2. Cooperative Spanish
3. Listening Comprehension
4. Pike Phonetic

Midtests and posttests (see 4.21.2)

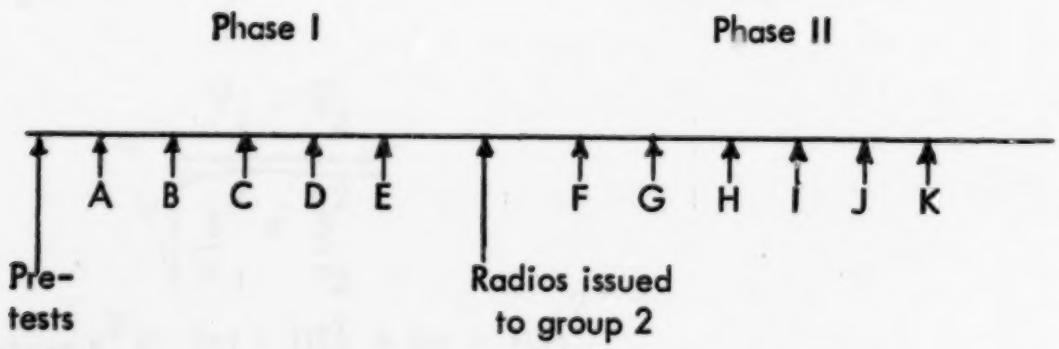
Phase I

Test A -	Department written No. 1	50 points
Test B -	Listening comprehension No. 1	27 points
Test C -	Department written No. 2	65 points
Test D -	Listening comprehension No. 2	25 points
Test E -	Stimulus written response No. 1	93 points

Phase II

Test F -	Department written No. 3	80 points
Test G -	Stimulus written response No. 2	125 points
Test H -	Department written No. 4	95 points
Test I -	Stimulus oral response No. 1	101 points
Test J -	Stimulus oral response No. 2 (final)	69 points
Test K -	Department written No. 5 (final)	160 points

4.23 Testing Plan



5. Analysis of Data.

5.1 Analysis of Pretest Scores. The following table gives pertinent information regarding the comparison of scores on four pretests given to both groups.

Table I

Means and Mean Differences of Four Pretest Scores for Group 1 and Group 2

	MLAT	Cooperative Spanish	Listening Comprehension	Pike Phonetic
Group 1 mean	63.5	98.9	3.25	11.8
Group 2 mean	55.3	79.8	2.27	11.9
Mean Difference	8.2	19.1	0.98	-0.1
Standard Error of Difference	4.94	11.35	0.75	1.92
Degrees of Freedom	25	23	25	25
t	1.66	1.68	1.30	-0.05

The variances of the two groups did not differ significantly in these or other computations throughout the experiment.

All comparisons were made using the standard t-test unless otherwise indicated. This measures the validity of the hypothesis that there is no significant difference between the means of the two groups for a specific test. That is, the null hypothesis Ho: $\mu_1 = \mu_2$ is tested against the alternative Hi: $\mu_1 \neq \mu_2$. Here:

$$t = \frac{\bar{Y}_1 - \bar{Y}_2}{\sqrt{\frac{S^2}{n_1} + \frac{S^2}{n_2}}}$$

$$\text{where } S^2 = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}$$

Thus S^2 is an estimate of the variance of the total population based on the variances of the control and experimental groups, i.e., the pooled estimate of σ^2.

If, in each case, the decision on the null hypothesis is made at the 0.05 level of significance, the two groups cannot be considered to be different, despite the fact that rather large positive differences exist between the means of the two groups for the MLAT, Cooperative Spanish, and the listening comprehension tests. In the light of these differences it is probable that the two groups do in fact differ with regard to initial ability, and further that the experimental group has scored higher than the control group.

Correlation analysis indicates that little or no correlation exists between pre-test scores and scores of any of the other tests. Although the previous analysis of pretests and subjective judgments on the part of class instructors indicate that group 1 was initially superior to group 2, it was not possible to remove this initial effect using any type of covariance adjustment of test scores based on pretest scores. Hence, it must be recognized that a certain degree of bias exists in the data and in the analysis of phase I when considered alone. The data from phase II, however, tend to remove the doubts produced by this bias.

5.2 Control Versus Experimental Comparisons. The following tables give pertinent information about the comparisons made between groups during both phases of the experiment:

Table II

Means, Mean Differences, and Mean Comparisons of Departmental Written Exams

	A	C	F	H
Experimental Group	44.1	58.7	58.2	71.7
Control Group	39.5	49.3	48.1	63.5
Difference	4.6	9.4	10.1	8.2
Standard Error of Difference	3.27	3.98	6.59	7.58
Degrees of Freedom	25	25	25	25
t[1]	1.41	2.36*	1.53	1.08

Radios issued to group 2

Table III

Means, Mean Differences, and Mean Comparisons of Listening Comprehension and Stimulus-response Tests

	B	D	E	G	I
Experimental Group	20.19	15.94	73.25	108.9	68.8
Control Group	15.45	13.27	51.09	90.9	56.0
Mean Difference	4.74	2.67	22.16	18.0	12.8
Standard Error of Difference	1.55	1.07	6.29	6.65	8.57
Degrees of Freedom	25	25	25	25	25
t	3.07*	2.50*	3.52*	2.70*	1.49

Radios issued to group 2

It was not expected that the radio broadcasts would cause an appreciable difference in the scores on the departmental written exams. However, it is seen from table III that the null hypothesis is rejected for test C. It is not possible to assert with any confidence that the difference here was caused by the radio broadcasts instead of some inherent difference between the two groups when this test is considered alone. However, when the differences between the two groups are compared from test to test, it is interesting to notice what seems to be a definite trend. The values of t (which are measures of the differences between the two groups) increased before the radios were given to the control group and decreased afterwards. This would appear to correspond with a cumulative effect which the radios would be expected to produce as their use continued, first in group 1 and then in group 2.

The same trend is observed in table III. This table shows the results of the analysis of tests involving oral-aural skills. The t values indicate differences which are clearly significant. It is possible that the "Hawthorne effect" is the reason the difference measured by test B is greater than that measured by test D. Students beginning a new semester in this type of experiment may have had an initial impetus which would decline as the novelty decreased. The greater difference observed on test E is perhaps due mostly to the fact that it was a more reliable measure of the skills which were being taught than were tests B and D. Some of the difference could be attributed to the cumulative effect of the radios, but there was a relatively short time lapse between tests D and E. Test H, which was the same type as test E, was administered only about two weeks after radios were given to group 2. While the difference in the means of the two groups is still significant on test H, a marked decrease is noticed. By the time test I was administered, a month later, the difference between the two means had become insignificant.

The trends observed in tables II and III seem to support the view that the significant differences indicated are not caused by inherent differences in the two groups.

5.3 Comparisons Within Group 2. The following table gives pertinent information regarding comparisons made within group 2. Test scores before the time when radios were issued to this group are compared with the scores of similar tests afterwards.

Table IV[2,3]

Analysis of Written and Oral-aural Exams: Scores Before Radios Were Issued versus Scores Afterwards

	A + C vs. F + H	E vs. G
Mean Difference	27.0	17.9
Standard Error of Difference	5.4	5.5
t	-5	3.25

The negative correlation in the comparison of the totals of tests A and C vs. F and H indicates that the percentage scores on the departmental tests dropped after the radios were given to this group. The same test scores in the experimental group also dropped as the semester progressed, as they did in all the other S 101 sections. The reason seems to be simply that the departmental tests were increasingly difficult.

On the other hand, there is a marked difference between the means of the stimulus-response test administered before group 2 received radios and the same type of test administered afterwards. Table IV shows that the mean scored on test G is significantly higher than that scored on test E. Test I cannot be compared with test E since the oral responses required made it considerably more difficult.

It is recognized that some of the difference between tests E and G could conceivably be attributed to better acclimatization to the program on the part of the

group concerned. It is felt, however, that the group was well acclimatized by the time test E was administered. This is particularly true in view of the fact that quizzes similar to test E were given almost every day.

It is also recognized that some of the difference between tests E and G could be caused by the "Hawthorne effect" but the evidence from table III seems to minimize this possibility, since the values of t continue to decrease, leaving even less difference between the two groups on test I.

5.4 Correlation Between the Amount of Drill Participation and Test Scores. Students could participate actively by listening and responding or passively by simply listening to the drills which were broadcast.

5.41 Correlations for Experimental Group. The correlation between drill totals for passive listening and the scores on test E is very low ($r = 0.153$). However, for some individuals passive drills were apparently very effective. The corresponding correlation computed with drills in which the students actively participated was quite substantial ($r = 0.575$).

5.42 Correlations for Control Group. The control group always participated in the drills by listening and responding since this part of their work was confined to the language laboratory. The correlation of their drill totals with test E was negative ($r = -0.215$). This seems to indicate that they did not receive sufficient drill in the language laboratory for it to be a controlling factor. But after this group received radios, the same type of comparison with a similar test (test G) showed a significant positive correlation ($r = 0.445$).

Information received on the weekly questionnaire supports the above inferences: The most frequent answer to the last question (What activities outside of class

have you found most helpful?) for the experimental group was almost always radios, but for the control group was almost never language laboratory.

5.5 Between-group Comparison of the Total Number of Drills per Student for Phase I. The average number of drills per student for the control group was 70. The same average for the experimental group was 789, or 11.3 times as many as for the control group. These include only the drills where active participation was involved.

It was felt that the students' reports on the number of drills was reasonably accurate. Several checks were incorporated in the daily report sheet for drills. The total number of complete programs as well as the percentage of correct responses on the last program had to be included. The latter could be compared with daily performance in class. The rate of battery replacement also provided a rough confirmation for students reporting large amounts of drill participation.

6. Conclusions. The evidence supporting the hypothesis is summarized in the five steps that follow. 1) The data indicate that students in the experimental group had approximately eleven times as much drill as those in the control group. 2) Although analysis of the pretest data does not lead to any type of covariance adjustment of subsequent test scores to eliminate an apparent bias in favor of the experimental group, other factors, as seen below, appear to overcome any possible distortions from this cause. 3) Further analysis shows that the experimental group attained significantly higher scores on most tests given during phase I and that the differences between the two groups gradually became insignificant after the control group received radios. 4) The control group shows a significant increase on stimulus-response test scores from phase I to phase II. 5) No significant correlation exists between amount of drill practice and stimulus-response test score in phase I for the control

group. In contrast, the corresponding comparisons for the experimental group, as well as the one for the control group in phase II, do show significant correlations.

It is recognized that evidence showing that the radios were effective in increasing language proficiency is valid only in so far as the tests which were administered were a proper measure of the speaking and understanding skills. It must be remembered particularly that the production tests were limited to measuring the correctness of a single response to a given cue. These tests were suitable for measuring the particular skills taught by this experimental program in which dialogues or conversations were not introduced. However, except where student recording facilities and activated headphones are considered important, there seems to be no reason why all the skills which have been successfully taught in the language laboratory could not also be taught by radio, with the possibility of a greatly increased exposure time.

7. Recommendations. The most important recommendation concerning any future study designed to test the present or related hypotheses concerns complete isolation of the control group from the experimental group. It is felt that the control and experimental parts of the experiment should be conducted during different semesters. This would prevent any feeling of unfair competition on the part of the control group and thus check the tendency of students to drop out of the program. It would also make possible the use of any radio frequency which might be desirable and available, e.g., the educational F. M. band.

The control group should be formed from at least two sections with fifteen to twenty-five students each. A similar experimental group could be formed in a later semester. The same teachers should be used for both groups.

It would seem wise for statistical reasons to administer fewer pretests. Also precautions should be taken to prevent students from purposely scoring low on pretests because of the

fear that high scores might lead to greater demands.

To make it easier for students to report the amount of time spent participating in the broadcasts, it is suggested that cumulative running time be recorded on the tapes at five-minute intervals. A student would then record only the amount of time he has listened.

A very rough check on the amount of time a receiver is used can be obtained by the comparative differences in battery life. But for this to be reliable, a sufficient number of batteries should be obtained at the beginning from one source since there seems to be a marked variation in life depending on the manufacturer.

8. Other Studies. As a result of this experiment certain other investigations are recommended. 1) Different types of radio systems which could be adapted for language teaching should be investigated and evaluated, especially ten-watt educational F.M. stations and carrier current systems. The feasibility of having students purchase their own standard F. M. or A.M. receivers for such systems should also be looked into. 2) The effectiveness of small receivers which can be easily carried should be compared with that of larger receivers which are likely to be used in only one location. Some means would have to be devised to make students willing to carry their radios with them since social factors are involved. 3) The adaptability of existing language materials for radio programming should be investigated. Most materials would have to be altered to permit effective passive listening. It seems that the stimulus-response-confirmation pattern provides the best approach for adapting any type of material.

APPENDIX

Form 1

Serial No. _____ Name _____
last first middle

I understand that the U. S. Communication Corp. Pagefone receiver, serial number _____, issued to me on _____, will be under my care until the termination of this agreement which may occur at any time before the end of the present semester. While the receiver will be serviced for normal repairs without charge to me, I take full responsibility up to the amount of $35.00 for any damage, loss, or theft which occurs during the time the receiver is in my possession. My deposit of $5.00 will help to avoid unnecessary delay in case repair for minor breakage is required, but all portions of this deposit not used to cover a loss for which I am liable will be returned. I agree to cooperate fully with the experiment in which I am participating. I understand that this includes daily class attendance and the accurate, honest reporting of data. I will in no way share this equipment with students in other Spanish 101 sections at Indiana University.

_____
Signature

Date of termination _____

Condition of receiver _____

Amount of deposit returned _____

APPENDIX

Form 2

Name _____ Date _____
Last First

hour	Drill ___ to Drill ___	Location	Time Listened	Listened only	Listened and Responded
7:30					
8:30					
9:30					
10:30					
11:30					
12:30					
1:30					
2:30					
3:30					
4:30					
5:30					
6:30					
7:30					
8:30					
9:30					
10:30					
11:30					

Do you think some drills should be repeated more times before the next drill is given? _____ Which? _____
Do you think some drills should be repeated less? _____ Which? _____

Which of the Spanish speakers do you prefer? Identify by drill number _____

How do you rate the performance of the system? _____
_____

Comments _____

_____

_____

Total programs listened only _____

Total programs listened and responded _____ per cent correct _____%

APPENDIX

Form 3

Name _____ Date _____
Last First

Instructor _____

The answers to the following questions will in no way affect your grade.

Approximately how long did you study for today's class? _____

How much extra time did you spend in the language laboratory during the last week? _____

What activities outside of class have you found most helpful? _____

_____

_____

APPENDIX

Pretest Scores[4] for Group 1

Student Number	MLAT	Cooperative Spanish	Listening Comprehension	Pike Phonetic
1	66	114	3	13
2	54	117	4	9
3	63	77	3	9
4	81	142	4	8
5	76	57	2	10
6	64		0	16
7	60	115	5	2
8	73	109	6	16
9	46	90	3	9
10	38	105	6	14
11	59	90	1	8
12	56	52	1	20
13	86	55	1	15
14	59	120	4	21
15	72	123	7	5
16	63	87	3	14

APPENDIX 4

Pretest Scores for Group 2

Student Number	MLAT	Cooperative Spanish	Listening Comprehension	Pike Phonetic
1	67	72	0	7
2	42	47	4	14
3	73		4	8
4	57	131	2	12
5	48	52	0	10
6	78	72	1	16
7	59	79	4	15
8	53	87	2	9
9	51	66	4	19
10	43	90	1	15
11	38	102	3	6

APPENDIX

Midtest and Posttest Scores for Group 1

Student Number	A	B	C	D	E	F	G	H	I	J	K
1	44.5	21	61	14	76	70	116	85	92	57	142.5
2	46.5	20	60.5	14	74	66.5	110	82	64	34	121
3	26.5	12	40.5	11	65	38.5	100	35	65	48	
4	40.5	24	41.5	16	72	36	113	58.5	61	44	117.5
5	47.5	26	55	14	91	65.5	123	90.5	89	68	151
6	49.5	23	62.5	20	87	77.5	123	89.5	79	61	159.5
7	43.5	17	52.5	16	66	52	99	61.5	59	52	121.5
8	46.5	23	60.5	20	86	67.5	113	84.5	86	58	143
9	49.5	24	63.5	17	85	75	124	86.5	84	63	148
10	32	16	33.5	12	38	9.5	63	27.5	53	25	
11	42	16	48	13	66	54.5	103	63.5	43	37	122
12	46	24	58.5	21	87	69	125	84	86	67	147
13	47.5	20	60	19	90	72.5	123	91	84	62	154
14	46.5	18	59.5	14	61	49	103	64	38	32	133.5
15	45.5	20	63.5	19	70	67	103		54	49	127
16	46	19	53.5	15	58	57	102	68.5	64	34	134

APPENDIX

Midtest and Posttest Scores for Group 2

Student Number	A	B	C	D	E	F	G	H	I	J	K
1	38.5	17	52.5	14	59	47	100	66	75	51	127
2	47.5	22	57	13	57	72	111	88.5	89	55	155.5
3	47.5	15	58	13	56	56	74	74.5	48	14	130
4	48.5	19	55	16	70	53	67	52.5	36	31	87
5	26	7	37.5	9	33	31.5	63	57	9	8	
6	43	17	59	12	70	55.5	113	68.5	70	64	136.5
7	38	11	40.5	13	45	31.5	92	51.5	76	44	85.5
8	49	20	62.5	15	72	76.5	119	86	91	52	158
9	16	13	23.5	13	49	26	88	24	52	37	
10	43.5	15	55	12	11	36.5	77	64	17	7	119.5
11	35	14	50	16	40	41.5	96	63.5	53	35	110

FOOTNOTES

1. The null hypothesis Ho: $\mu_1 = \mu_2$ will be rejected in favor of the alternate hypothesis Ha: $\mu_1 \neq \mu_2$ if $t \geq 2.06$ at the 0.05 level of significance. Significant differences are indicated by an asterisk (*).
2. Since comparisons are made within the same group, the paired t-test is used to give more precise results. The null hypothesis Ho: $\mu_1 = \mu_2$ will be rejected in favor of the alternate hypothesis Ha: $\mu_1 \neq \mu_2$ if $t \geq 2.23$ at the 0.05 level of significance.
3. The means in this computation have been adjusted to percentage values for the purpose of comparing tests of different weight.
4. Scores are omitted for students whose data is relatively incomplete.